

What Is Claimed Is:

1 1. A method for communicating between a first semiconductor die
2 and a second semiconductor die through optical signaling, comprising:
3 converting an electrical signal into an optical signal using an electrical-to-
4 optical transducer located on a face of the first semiconductor die;
5 wherein the first semiconductor die and the second semiconductor die are
6 oriented face-to-face so that the optical signal generated on the first
7 semiconductor die shines on the second semiconductor die;
8 receiving the optical signal on a face of the second semiconductor die; and
9 converting the optical signal into a corresponding electrical signal using an
10 optical-to-electrical transducer located on the face of the second semiconductor
11 die.

1 2. The method of claim 1, wherein after generating the optical signal
2 on the first semiconductor die, the method further comprises passing the optical
3 signal through annuli located within metal layers on the first semiconductor die to
4 focus the optical signal onto the second semiconductor die.

1 3. The method of claim 1, wherein after generating the optical signal
2 on the first semiconductor die, the method further comprises using a lens to focus
3 the optical signal onto the second semiconductor die.

1 4. The method of claim 1, wherein after generating the optical signal
2 on the first semiconductor die, the method further comprises using a mirror to
3 reflect the optical signal, so that the optical signal can shine on the second

4 semiconductor die without the first semiconductor die having to be coplanar with
5 the second semiconductor die.

1 5. The method of claim 1, wherein after generating the optical signal
2 on the first semiconductor die, the method further comprises passing the optical
3 signal through an interposer sandwiched between the first semiconductor die and
4 the second semiconductor die, wherein the interposer contains one or more
5 waveguides that direct the optical signal, so that the optical signal shines on the
6 second semiconductor die.

1 6. The method of claim 1,
2 wherein the electrical-to-optical transducer is a member of a plurality of
3 electrical-to-optical transducers located on the first semiconductor die; and
4 wherein the optical-to-electrical transducer is a member of a plurality of
5 optical-to-electrical transducers located on the first semiconductor die;
6 whereby a plurality of optical signals can be transmitted in parallel from
7 the first semiconductor die to the second semiconductor die.

1 7. The method of claim 6,
2 wherein multiple spatially adjacent electrical-to-optical transducers in the
3 plurality of electrical-to-optical transducers transmit the same signal; and
4 wherein electronic steering circuits in the first semiconductor die direct
5 data to the multiple spatially adjacent electrical-to-optical transducers to correct
6 mechanical misalignment in X , Y and θ coordinates.

1 8. The method of claim 6,

2 wherein multiple spatially adjacent optical-to-electrical transducers in the
3 plurality of optical-to-electrical transducers receive the same signal; and
4 wherein electronic steering circuits in the second semiconductor die direct
5 data from the multiple spatially adjacent optical-to-electrical transducers to correct
6 mechanical misalignment in X , Y and Θ coordinates.

1 9. The method of claim 1, wherein the electrical-to-optical transducer
2 includes one of:

3 a Zener diode;
4 a light emitting diode (LED);
5 a vertical cavity surface emitting laser (VCSEL); and
6 an avalanche breakdown P-N diode.

1 10. The method of claim 1, wherein the optical-to-optical transducer
2 includes one of:

3 a P-N-diode photo-detector; and
4 a P-I-N-diode photo-detector.

1 11. An apparatus for communicating between semiconductor chips
2 through optical signaling, comprising:

3 a first semiconductor die;
4 a second semiconductor die;
5 an electrical-to-optical transducer located on a face of the first
6 semiconductor die, which is configured to convert an electrical signal into an
7 optical signal;

8 wherein the first semiconductor die and the second semiconductor die are
9 oriented face-to-face so that the optical signal generated on the first
10 semiconductor die shines on the second semiconductor die;
11 an optical-to-electrical transducer located on a face of the second
12 semiconductor die, which is configured to convert the optical signal received from
13 the first semiconductor die into a corresponding electrical signal.

1 12. The apparatus of claim 11, further comprising annuli located
2 within metal layers on the first semiconductor die configured to focus the optical
3 signal onto the second semiconductor die.

1 13. The apparatus of claim 11, further comprising a lens configured to
2 focus the optical signal onto the second semiconductor die.

1 14. The apparatus of claim 11, further comprising a mirror configured
2 to reflect the optical signal, so that the optical signal can shine on the second
3 semiconductor die without the first semiconductor die having to be coplanar with
4 the second semiconductor die.

1 15. The apparatus of claim 11, further comprising an interposer
2 sandwiched between the first semiconductor die and the second semiconductor
3 die, wherein the interposer contains one or more waveguides that direct the optical
4 signal, so that the optical signal shines on the second semiconductor die.

1 16. The apparatus of claim 11,
2 wherein the electrical-to-optical transducer is a member of a plurality of
3 electrical-to-optical transducers located on the first semiconductor die; and

4 wherein the optical-to-electrical transducer is a member of a plurality of
5 optical-to-electrical transducers located on the first semiconductor die;
6 whereby a plurality of optical signals can be transmitted in parallel from
7 the first semiconductor die to the second semiconductor die.

1 17. The apparatus of claim 16,
2 wherein multiple spatially adjacent electrical-to-optical transducers in the
3 plurality of electrical-to-optical transducers transmit the same signal; and
4 wherein electronic steering circuits in the first semiconductor die direct
5 data to the multiple spatially adjacent electrical-to-optical transducers to correct
6 mechanical misalignment in X , Y and Θ coordinates.

1 18. The apparatus of claim 16,
2 wherein multiple spatially adjacent optical-to-electrical transducers in the
3 plurality of optical-to-electrical transducers receive the same signal; and
4 wherein electronic steering circuits in the second semiconductor die direct
5 data from the multiple spatially adjacent optical-to-electrical transducers to correct
6 mechanical misalignment in X , Y and Θ coordinates.

1 19. The apparatus of claim 11, wherein the electrical-to-optical
2 transducer includes one of:
3 a Zener diode;
4 a light emitting diode (LED);
5 a vertical cavity surface emitting laser (VCSEL); and
6 an avalanche breakdown P-N diode.

1 20. The apparatus of claim 11, wherein the optical-to-optical
2 transducer includes one of:

3 a P-N-diode photo-detector; and

4 a P-I-N-diode photo-detector.

1 21. A computer system including semiconductor chips that
2 communicate with each other through optical signaling, comprising:

3 a first semiconductor die containing one or more processors;

4 a second semiconductor die containing circuitry that communicates with
5 the one or more processors;

6 an electrical-to-optical transducer located on a face of the first
7 semiconductor die, which is configured to convert an electrical signal into an
8 optical signal;

9 wherein the first semiconductor die and the second semiconductor die are
10 oriented face-to-face so that the optical signal generated on the first
11 semiconductor die shines on the second semiconductor die;

12 an optical-to-electrical transducer located on a face of the second
13 semiconductor die, which is configured to convert the optical signal received from
14 the first semiconductor die into a corresponding electrical signal.

1 22. The computer system of claim 21, further comprising annuli
2 located within metal layers on the first semiconductor die configured to focus the
3 optical signal onto the second semiconductor die.

1 23. The computer system of claim 21, further comprising a lens
2 configured to focus the optical signal onto the second semiconductor die.

1 24. The computer system of claim 21, further comprising a mirror
2 configured to reflect the optical signal, so that the optical signal can shine on the
3 second semiconductor die without the first semiconductor die having to be
4 coplanar with the second semiconductor die.

1 25. The computer system of claim 21, further comprising an interposer
2 sandwiched between the first semiconductor die and the second semiconductor
3 die, wherein the interposer contains one or more waveguides that direct the optical
4 signal, so that the optical signal shines on the second semiconductor die.

1 26. The computer system of claim 21,
2 wherein the electrical-to-optical transducer is a member of a plurality of
3 electrical-to-optical transducers located on the first semiconductor die; and
4 wherein the optical-to-electrical transducer is a member of a plurality of
5 optical-to-electrical transducers located on the first semiconductor die;
6 whereby a plurality of optical signals can be transmitted in parallel from
7 the first semiconductor die to the second semiconductor die.

1 27. The computer system of claim 26,
2 wherein multiple spatially adjacent electrical-to-optical transducers in the
3 plurality of electrical-to-optical transducers transmit the same signal; and
4 wherein electronic steering circuits in the first semiconductor die direct
5 data to the multiple spatially adjacent electrical-to-optical transducers to correct
6 mechanical misalignment in X , Y and θ coordinates.

1 28. The computer system of claim 26,

2 wherein multiple spatially adjacent optical-to-electrical transducers in the
3 plurality of optical-to-electrical transducers receive the same signal; and
4 wherein electronic steering circuits in the second semiconductor die direct
5 data from the multiple spatially adjacent optical-to-electrical transducers to correct
6 mechanical misalignment in X , Y and Θ coordinates.

1 29. The computer system of claim 21, wherein the electrical-to-optical
2 transducer includes one of:

3 a Zener diode;
4 a light emitting diode (LED);
5 a vertical cavity surface emitting laser (VCSEL); and
6 an avalanche breakdown P-N diode.

1 30. The computer system of claim 21, wherein the optical-to-optical
2 transducer includes one of:

3 a P-N-diode photo-detector; and
4 a P-I-N-diode photo-detector.